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ABSTRACT

The Rocky Mountain (Colorado) Teacher Education Collaborative was awarded a grant by the National Science Foundation to improve the preparation of science and math teachers and to recruit and retain underrepresented groups in math and science education. As part of this grant project, a survey was conducted of women science educators to assess their perceptions of their own past science learning. Two hundred copies of an 85-item survey were distributed to Colorado women science educators in Fall 1996; of these, 80 women responded. Data analysis indicated: women who have been successful in science affirm for all people an equal opportunity to learn; they like to be challenged; and they persist and try harder even when faced with hardships of initial failure; these women are creative and like to analyze things; they rely on their inner resources and describe themselves as independent thinkers and strategic planners. Based on the survey, two conclusions are advanced: (1) women succeed in science when they are able to persist in the face of hardship; and (2) women succeed in science when they try alternate strategies to increase their science learning. The survey is appended with details of item responses. (JLS)

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ED 405 340

Women Who Say 'Yes' When Science Says 'No': Their Lessons for Future Students and Teachers

A Presentation for
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Women Who Say 'Yes' When Science Says 'No':
Their Lessons for Future Students and Teachers

A Survey of Women Science Educators in Colorado
Through the Rocky Mountain Teacher Education Collaborative
a CETP funded by the National Science Foundation

Presenters
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Introduction

In June, 1994, the National Science Foundation funded a grant for three Colorado colleges to become a "Collaborative for Excellence in Teacher Preparation" (CETP). The Rocky Mountain Teacher Education Collaborative (RMTEC), representing Metropolitan State College of Denver, University of Northern Colorado in Greeley, and Colorado State University in Fort Collins, now in its third year, was awarded five million dollars over five years to improve the preparation of science and math teachers and to recruit and retain underrepresented groups in math and science teacher preparation and teaching. Today's presenters share an interest in one important part of the grant initiative. They conducted a survey of women science educators in Colorado during fall, 1996 to assess their perceptions of their own past science learning. Colorado women's responses on the "Women Science Educators' Survey of Factors Leading to Career Choice" suggest lessons for future women students' success in science classes. It is hoped that these lessons will play some role in encouraging and supporting women to pursue science teaching.

In The Lenses of Gender Sandra Lipsetz Bem (1993) describes how individuals growing up in American society develop certain cultural lenses through which they view experience. In feminist pedagogy, "standpoint theorists" reflect this perspective. Men and women develop conventional "gendered selves," and automatically make certain choices, often leading to

different and unequal life situations. The focus here is on just one of these choices--the decision many American women make **not** to pursue science and math.

Many suggest that science is 'masculine,' as taught. The examples are masculine, classroom interactions are dominated by males, and even assessments tend to be biased in favor of males (AAUW, 1992; Sadker & Sadker, 1994; 1990; Rosser, 1990; Tobias, 1992). Considerable documentation (AAUW, 1992) exists to demonstrate how women's choices not to pursue science are reinforced daily by experiences in and out of school. To turn this around, women must refuse to accept the cultural norm that communicates to them that they do not belong in science. If women develop their awareness of gender equity issues they may be able to take such a stand.

In analyzing why women are underrepresented in science classes and science teaching, Belenky's research provides some answers (1986). She suggests that, based on their different and 'gendered' experience in American society, women have a different set of learning needs in science. Further, she suggests that these learning needs are not met. To the extent that science is characterized as value-free and objective, women may find the learning cold, disconnected, and meaningless. Because many women value a more connected way of knowing, they may feel out of place in science classes (Belenky, 1986).

In Colorado, one of the many symptoms of male domination in science is the significant disparity between the number of men and the number of women who have become secondary science teachers. Recent statistics from the Colorado Department of Education (1995) indicate that twice as many men as women teach science in high schools statewide. The problem is complex because the current under supply of women teachers contributes to it. The existing gender disparity in the science teaching force sends a message everyday to both male and female students in Colorado--a message that 'science is a man's field'. Fortunately, some women refuse to accept this message.

The occasional young woman continues to pursue science, and many such women find success as science teachers. The masculine environment does not drive her out; the paucity of female teachers does not prevent her from pursuing her goals. How does she succeed? The current study rests upon the belief that the voice and experience of women who say 'yes' to science, even

when science classes say 'no' to them, can direct us toward greater gender equity in the field of science education. From them, women may learn how to survive and succeed in science.

There are various theories describing human qualities that lead people toward success in spite of odds. In models of resiliency, mastery-oriented learning, and self-efficacy, typical behaviors that characterize 'survivors' are identified. By way of example, seven factors are identified as central to resiliency: insight; relationships; independence; initiative; creativity; humor; morality (Wolin & Wolin, 1995). Four strengths are said to characterize "mastery-oriented learners" (Girls Educational Achievement Project, 1995, 17): the abilities to develop alternate strategies, to persist through frustration, to tolerate ambiguity; and to take risks.

Herb Kohl (1991) describes the human quality of intentionally "**not-learning**" certain messages advanced in both the formal and hidden curriculum of society and schools. Kohl applauds students who are alert to, and reject, messages about racism, sexism, and classism. Similarly, Bem (1993) describes the benefits people experience when they develop an 'oppositional consciousness,' and look ***at*** the cultural lens of the dominant society rather than ***through*** it (1993, 169). Bem urges women to be aware, for example, of the ways hidden assumptions may be teaching them to avoid science. Through such awareness, she explains, comes persistence, empowerment, and choice. By incorporating survey items referencing the characteristics of people who succeed in spite of odds, the current study assesses women science educators' resiliency, mastery-oriented learning, and 'oppositional consciousness.'.

Two hundred copies of an 85 item survey entitled "Science Educators' Assessment of Factors Leading to Career Choice" were distributed to Colorado women science educators in fall, 1996. Eighty women responded. Findings describe typical characteristics of women science educators' personal histories, significant science teachers, approaches to science learning, and social/ environmental contexts.

In this AACTE presentation Dr. Swetnam will highlight selected findings about women's personal histories, Dr. Taylor will highlight characteristics of women educators' approaches to science learning, and Dr. Friot will offer reflections on women's open-ended responses. Summaries will be distributed describing other findings. The study is a work in progress.

Interviews and observations are planned with survey respondents who volunteered to participate in follow up investigations. The remainder of this presentation paper will focus on Women Science Educators' Approaches to Science Learning.

Women Science Educators' Approaches to Science Learning
(Survey Items 32-57, "Science Educators' Assessment of Factors Leading to Career Choice")

From the data representing women who became science educators, we culled out the approaches to science learning that were most typical. It was hoped from this approach to suggest women's "science survival strategies." Respondents presented answers on Likert scales (1-5) to indicate that characteristics were "not like me" or "like me." Means were calculated for the 26 items. Survey items were influenced primarily by models of resiliency (Wolin & Wolin, 1995) and mastery-oriented learning (Girls Educational Achievement Project, 1995, 17). The five highest ranked beliefs or attributes were:

Mean Responses (on a five point scale)

- 4.86 I believe all should have an equal opportunity to learn.
- 4.49 I like to be challenged.
- 4.39 I select alternative strategies if the first approach fails.
- 4.39 I think it is okay to make mistakes.
- 4.31 I take initiative to make things work even with hardship.

In brief, Colorado women who have been successful in science affirm their own, and everyone's, equal opportunity to learn. They like to be challenged, and they persist and try harder rather than giving up--even when faced with mistakes, hardship, and/or initial failure. Further analysis of the data suggests that they are creative and like to analyze things. They rely on their inner resources and describe themselves as independent thinkers and strategic planners.

Further analysis of the data will follow. Preliminary analysis does reflect one notable pattern of response. Colorado women science educators show a distinctive profile of strengths: in many different items they describe themselves as people who **develop alternate strategies** and **persist though frustration**. These findings confirm the particular importance of two characteristics noted in the model of "mastery-oriented learning" and suggest the value of working with future science students to develop these approaches(Girls Educational Achievement Project, 29). Girls Count has developed an educators' guide entitled I did it! An educator's guide to developing mastery-oriented learners (1995) that does just this. *(The other two Girls Count categories of mastery-oriented behavior, **tolerance for ambiguity** and **willingness to take risks** were not as typical of the population of women science educators.)*

Implications

Based on survey data regarding approaches to science learning of women who have become science educators, two conclusions and related implications are advanced:

1) **Women succeed in science when they are able to persist in the face of hardship**.

What lesson can we draw from this finding?

A variety of tools may help future women science students to persist. Women's persistence may be enhanced if they develop their awareness of gender bias in science and recognize how women are sometimes taught to avoid science. Knowing this, they can consciously choose to "not learn" messages that discourage their pursuit of science. They can urge their science teachers to broaden what they honor as science learning and address within science the connections to lived experience that may motivate women learners, enhance their persistence, and support their 'ways of knowing.'

2) **Women succeed in science when they try alternate strategies to increase their science learning**.

Future women students need to develop the insight one mistake does not constitute failure. Women need to develop the confidence and flexibility

to try alternative approaches, especially when the first approach fails. Science teachers need to encourage multiple approaches to problem solving, give more focus to the process of learning and developing understanding.

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Science Educators' Assessment of Factors Leading to Career Choice

conducted by

The Rocky Mountain Teacher Education Collaborative

(funded by the National Science Foundation)

Personal Information

1. Please check the level you teach or plan to teach.

   Elementary _____
   Middle School _____
   High School _____
   College _____

2. What was your undergraduate college major? _____

3. If you attended graduate school, what was your field?_____ Degree?_____.

4. Please check the category that best describes your area of teaching.

   Life Science _____
   Earth Science _____
   Physical Science _____
   Science Generalist _____
   Elementary Teacher
   With Interest In Science_____

5. How many years have you taught? _____ _____
   pre-service # of years

6. What is your birth order? _____ _____ _____ _____
   only child first child middle child last child

7. Who were your most inspirational science teachers?

   *Name of teacher*_____*Grade*_____*Gender*_____*School*_____

   *Name of teacher*_____*Grade*_____*Gender*_____*School*_____

   *Name of teacher*_____*Grade*_____*Gender*_____*School*_____

8. Please circle your ethnic or racial background. (Optional)

   African American Asian American Hispanic American

   American Indian White Other

9. As a child were you more like a

   1 2 3 4 5
   "Tomboy" "Little Princess"

10. Was your relationship with your father

1	2	3	4	5
"Daddy's pal"				"Daddy's little girl"

11. Do you feel equally comfortable working with and communicating with male and female colleagues ?

1	2	3	4	5
more with female		equally with both		more with male

12. Did you have any K-12 women science teachers? **yes no** (circle) If so, how many?_____

13. Did you have any women science mentors? **yes no** (circle) If so, how many?_____

14. Was your mother in a science related field? **yes no** (circle)

15. Was your father in a science related field? **yes no** (circle)

16. Have you had professional experience in a science occupation(other than teaching) working for a year or more? **yes no** (circle)

- If previous answer is yes, what job?_____
- How long did you hold that job?_____
- Why did you leave to become teacher?_____

_____

17. Assess the quality of your science experience at these levels:

	Poor	Satisfactory	Very Good
Out of school	1	2	3
Elementary	1	2	3
Junior/Middle	1	2	3
High School	1	2	3
College	1	2	3

18. When did you first recognize your interest in science? (Please check the best response.)

Elementary	_____
Middle/Junior High	_____
High school	_____
College	_____
After teaching awhile	_____

19. When you decided you were interested in pursuing science which did you first choose?

_____ career in science other than teaching

_____ career in teaching science

Significant Science Teacher

Describe the science teacher who was most significant in your K-12 education according to the following contrasting terms. *He or she:*

20.	1	2	3	4	5	
	rarely praised students					often praised students
21.	1	2	3	4	5	
	humiliated students					showed courtesy to students
22.	1	2	3	4	5	
	doubted that student knowledge was relevant					confirmed students' prior knowledge
23.	1	2	3	4	5	
	looked down upon students					respected students
24.	1	2	3	4	5	
	seemed remote from students					seemed connected to students
25.	1	2	3	4	5	
	emphasized debate					emphasized collaboration
26.	1	2	3	4	5	
	discouraged diversity of opinion					welcomed diversity of opinion
27.	1	2	3	4	5	
	emphasized problem posing					emphasized lecture
28.	1	2	3	4	5	
	emphasized "out of context" learning					built learning from students' experience
29.	1	2	3	4	5	
	seemed omniscient					seemed like a partner
30.	1	2	3	4	5	
	emphasized "subordination"					emphasized "cooperation"
31.	1	2	3	4	5	
	imposed voice of scientific authority					helped students see things in own way

Characteristics That May Impact Success or Failure in Science Classes

Below are a series of statements, some positive and some negative, that describe characteristics and strategies that may be connected to level of success/failure in science. On a scale of 1-5 describe these characteristics as "not like me" or "like me."

		Not Like me				*Like Me*
32.	I like to take risks.	*1*	*2*	*3*	*4*	*5*
33.	I am an independent thinker.	*1*	*2*	*3*	*4*	*5*
34.	I have difficulty adjusting to change.	*1*	*2*	*3*	*4*	*5*
35.	I seek familiar activities.	*1*	*2*	*3*	*4*	*5*
36.	I select alternative strategies if the first approach I try fails.	*1*	*2*	*3*	*4*	*5*
37.	I feel very anxious about failing in science classes.	*1*	*2*	*3*	*4*	*5*
38.	I like to be challenged.	*1*	*2*	*3*	*4*	*5*
39.	I tend to underestimate my abilities in science.	*1*	*2*	*3*	*4*	*5*
40.	I take initiative to make things work even with hardship.	*1*	*2*	*3*	*4*	*5*
41.	I believe everyone should have an equal opportunity to learn.	*1*	*2*	*3*	*4*	*5*
42.	I have a high tolerance for ambiguity and confusion.	*1*	*2*	*3*	*4*	*5*
43.	I'm a strategic planner.	*1*	*2*	*3*	*4*	*5*
44.	I commonly use positive self-talk.	*1*	*2*	*3*	*4*	*5*
45.	I attribute my confusion to lack of intelligence in science.	*1*	*2*	*3*	*4*	*5*
46.	I'm not afraid of failure.	*1*	*2*	*3*	*4*	*5*
47.	I rely on my inner resources.	*1*	*2*	*3*	*4*	*5*
48.	I decrease effort when I fail.	*1*	*2*	*3*	*4*	*5*
49.	I like analyzing things.	*1*	*2*	*3*	*4*	*5*
50.	I have developed insight that helps me deal with gender issues within the social context of science classes.	*1*	*2*	*3*	*4*	*5*
51.	I am creative about finding new ways to problem solve.	*1*	*2*	*3*	*4*	*5*
52.	I think it is okay to make mistakes.	*1*	*2*	*3*	*4*	*5*
53.	I seek relationships with science mentors.	*1*	*2*	*3*	*4*	*5*
54.	I can persist through frustration.	*1*	*2*	*3*	*4*	*5*
55.	If I don' t succeed I try harder.	*1*	*2*	*3*	*4*	*5*
56.	I have a sense of humor that helps me through difficult times.	*1*	*2*	*3*	*4*	*5*
57.	I go about science differently from typical science teachers.	*1*	*2*	*3*	*4*	*5*

Social /Environmental Context

Circle the following items as they reflect your experience:

T (true), or F (false), or N (not applicable)

58. T F N raised to believe in equal opportunity for girls and boys.
59. T F N pursued science learning outside of school courses.
60. T F N played with science kits and science projects as a child.
61. T F N had strong science background in elementary school.
62. T F N had single gender (all girl or all boy) science classes.
63. T F N family intentionally taught that science was not for girls.
64. T F N family unconsciously taught that science was not for girls.
65. T F N the media conveyed gender stereotypes that discouraged my science interest .
66. T F N peers taught me that science was not for girls.
67. T F N I like to play bridge, chess, or other strategy games.
68. T F N I attended public school for most of my schooling.
69. T F N I attended private school for most of my schooling.
70. T F N I had an adult mentor in science.
71. T F N I had a peer mentor in science.
72. T F N I hid my interest/aptitude in science from friends.
73. T F N I work to please others.
74. T F N I work to please myself.
75. T F N I am a critical thinker.
76. T F N I am resilient in the face of hardship.
77. T F N My parents expected me to succeed in science.
78. T F N Faculty at school interacted with my home regularly.
79. T F N I had a different concept from the standard one taught of the preferred behavioral mode of a scientist.
80. T F N I took algebra in eighth grade.

Learning Experiences in Science Classes

81. Describe the most memorable science class you took.
Topic/name of course:_____Grade level:_____Teacher Gender:_____

82. What was your hardest challenge as a woman preparing to teach science?

83. Tell anything else you think is significant about your decision to become a science teacher or your success in reaching that goal.

84. What can be done to encourage more girls to become science teachers?

Women Science Educators Survey of Factors Leading to Career Choice

Participants were solicited from all over Colorado through notices in the Colorado Association of Science Teachers (CAST) and Colorado Connections newsletters as well as the CONNECT computer network. A large number of surveys were distributed to female science teachers participating in the CAST annual conference.

A total of 250 surveys were distributed to women science educators at all educational levels. 80 teachers responded for a return rate of 32%.

Summary of Demographic Results:

Teacher's grade level

Elementary	40%
Middle School	38%
High School	35%
College	6%

(Some have taught at more than one level)

Undergraduate major

Life Science	39%
Chemistry	5%
Geology	4%
Other Science	6%
Elementary	22%
Other non-sci.	24%

Graduate majors

33 had no graduate degree
18 Science
16 Education
5 Elementary
4 Math
4 Other

Current field of teaching

Life Sci.	41%
Earth Sci.	24%
Physical Sci.	29%
General Sci.	24%
Elementary Sci	30%

(Some teach in more than one area)

Years of experience in teaching

Pre-service	13%
1-5 years	33%
6-10 years	20%
11-15 years	8%
16-20 years	14%
21-30 years	10%
30+ years	1%

Teacher's birth order

Only child	5%
Oldest child	53%
Middle child	28%
Youngest child	15%

Teacher's race

Anglo	75
Hispanic	4
Multi racial	1

Of the 128 most inspirational science teachers named by these women science educators 48 (38%) were women.

Grade levels of the most inspirational teachers

Elementary	7
Middle School	18
High School	58
College	35

Childhood behavior pattern

54% reported being more like a "Tomboy" than a "Little Princess" 13%

Relationship with father

24% reported being more like "Daddy's Pal" while 30% were "Daddy's Little Girl"

Gender working and communication preferences

10% reported being more comfortable working and communicating with women colleagues. 64% reported equally comfortable professional relationships with both men and women and 25% reported being more comfortable working and communicating with men.

71% of the respondents had at least one woman science teacher during their school years.

18% reported that their mother was employed in a scientific field.

33% reported that their father was employed in a scientific field.

39% of the teachers reported having one or more years work experience in science outside of teaching

When asked about the quality of their science experiences the respondents rated the following on a scale of 1=poor to 3=very good.

Elementary	1.62
Middle School	1.86
High School	2.33
College	2.56
Outside Experiences	2.38

The respondents indicated the level at which they first recognized their interest in science

Elementary	26%
Middle School	20%
High School	28%
College	16%
After teaching a while	10%

46% indicated that they had chosen a career in a science field before turning to teaching.

41% chose a career in teaching as their first choice.